INTERPOLATION OF UTILITY AND ENVIRONMENTAL RESULTS FROM NEMS-BT OUTPUT

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APPENDIX 14A. INTERPOLATION OF UTILITY AND ENVIRONMENTAL RESULTS FROM NEMS-BT OUTPUT

The effects of proposed home appliances energy-efficiency standards on the electricity and natural gas industries were analyzed using a variant of the U.S. DOE/EIA National Energy Modeling System (NEMS) called NEMS-BT, together with some exogenous calculations. Because the relative size of the energy savings being implemented in NEMS-BT is too small to be seen in the context of the whole electricity and natural gas utility sector, NEMS-BT is not used directly. Rather, exploratory runs are conducted to estimate marginal effects, which are then used to calculate the small effects due to each proposed trial standard level.

To run a simulation in NEMS-BT, the Residential Demand Module cooking load or the Commercial Demand Module water heating load is reduced annually according to the energy savings estimated by the National Energy Savings model (see Chapter 13) for a given trial standard level. These energy savings increase over time and are distinguished by fuel type (electricity, natural gas, LPG, and oil).

The magnitude of the energy decrement that would be required for NEMS-BT to produce stable results safely out of the range of numerical noise is greater than even the most stringent standard under consideration. Therefore, it has been necessary, in both the utility analysis and environmental assessment, to estimate results in the range of the standard levels effects using interpolation. Interpolated values are derived from a series of higher decrement simulations based on the standard levels. The actual annual savings attributed to each standard level are compared between standard levels, and those with similar energy savings patterns over time are grouped together. One set of simulations is run for each of the savings groups. The standard levels for the residential and commercial home appliances analysis were modeled separately for each appliance:

Residential Cooking Standard Level 4: used to model Standard Levels 1, 2, and 3.
Residential Microwave Ovens Standard Level 4: used to model Standard Levels 1, 2, and 3.

To preserve the pattern of energy savings over time for a trial standard level, savings in each year were multiplied by the same factor. This factor varies between standards because the magnitude of the savings changes. An appropriate set of multipliers was chosen to augment the savings to a magnitude that produces credible results. Using professional judgement, sets of three or four multipliers were selected for each of the modeled trial standard levels as shown in Table 14A.1.

Table 14A.1 Set of Multipliers for Various Home Appliance Standards

Cooking Trial Standard Level 4	25, 50, 60, 75
Microwave Oven Trial Standard Level 4	50, 100, 150, 200

The output for electricity generation and capacity by fuel type for each of the iterations (e.g., 25, 50, and 75 times the standard level) is then regressed, with the y-intercept forced through the origin, and the actual standard level forecast is interpolated along this regression line. The linear regression is forced through the origin because a zero change must be the case with no standard in place and because the target points of interpolation are close to the origin (i.e., at low energy decrements).

Figure 14A.1 shows an example of the interpolation approach for a proposed trial standard level X1. The magnitude of the energy savings multiplier is plotted on the x-axis against the reduction in coal installed generating capacity for each reported year, as shown by the various plotted lines. In general, results for the various NEMS-BT runs are reasonably stable and linear, with the noisy behavior appearing below the first multiplier of the trial standard level savings decrement.

The Department used the interpolated total fuel generation at each trial standard level to determine emissions savings. Wherever possible, the environmental assessment analysis used marginal emissions rates over average emissions rates. However, as will be discussed further in this appendix, difficulties arose with using marginal rates in all circumstances and alternative methods needed to be used. Marginal emissions rates incorporate both effects of the standards—the emissions saved by the reduction in total generation and the slight change in the emissions characteristics of the whole power sector that result from the slight change in dispatch and capacity expansion plan. The net effect on the entire system is very small and, typically, the overall effect on emissions can be fully attributed to the decremented generation. The annual marginal emissions rates at the trial standard level were extrapolated from these rates (at multipliers of the trial standard level savings) by taking a simple average.

Figure 14A.2 shows an example of the extrapolation for NOx emissions rates for trial standard level X1. In this case, marginal rates for NOx emissions are shown for each year. As is evident in the figure, more stable results are produced at higher levels of demand decrement. At lower decrement levels (i.e., both on the left-hand side of the figure and in years with small standards impacts), the emissions rate is quite variable. The dashed lines show the earlier years of the imposed standard—those in which the decrements to demand are smallest. The constant emissions rates at higher decrement levels are therefore assumed to hold in the range of small decrements commensurate with the various standard levels and the implied marginal emissions rates are used to estimate emissions reductions.

Wherever possible, the Department calculated annual marginal emissions rates for each of the simulations in each modeled standard level, based on the actual output from NEMS-BT. Total emissions savings in each year are the product of the annual marginal emissions rate and

the reduction in generation (by fuel or collectively) for that year (as calculated by the interpolation method described above).

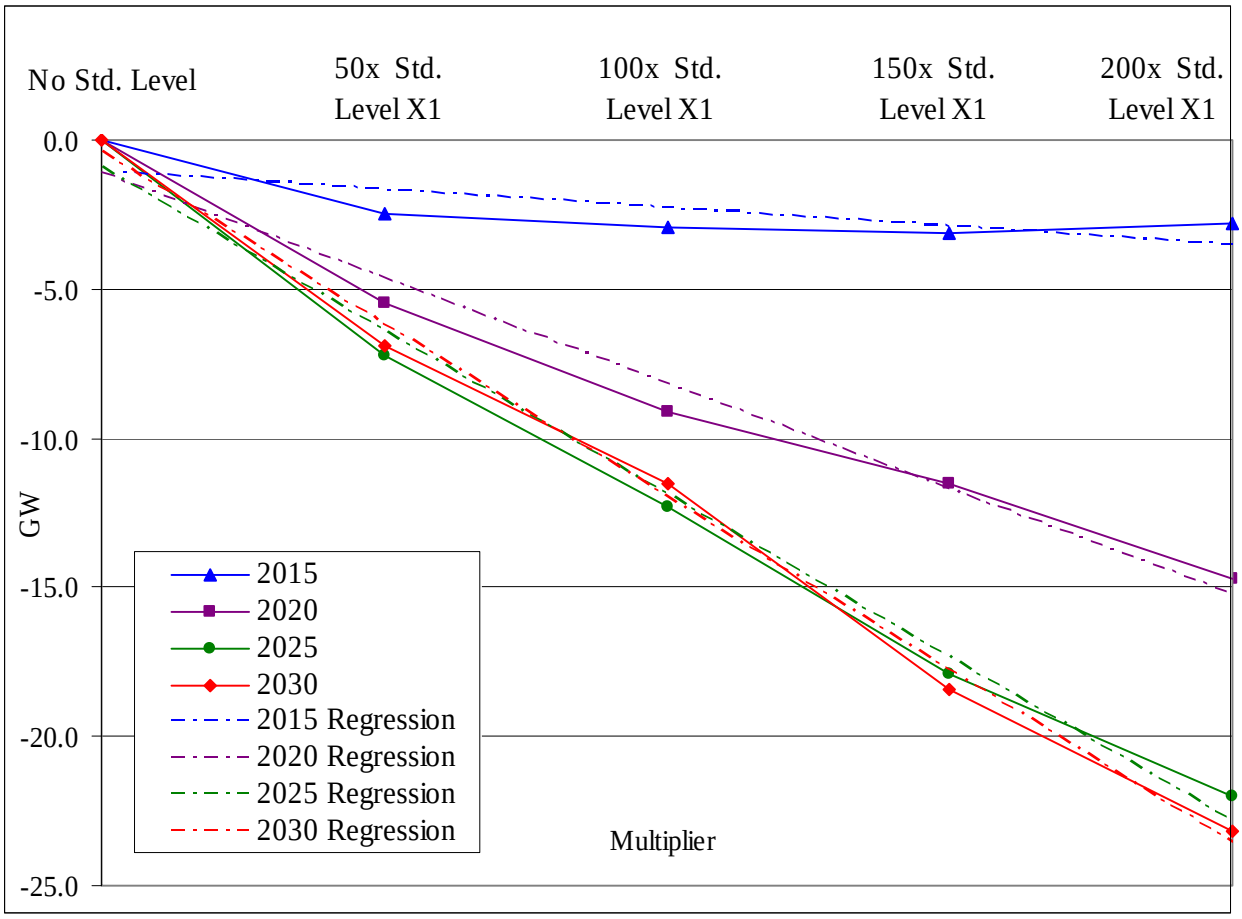

Figure 14A.1 An Example of Interpolation of a Trial Standard Level: Difference in Coal Capacity

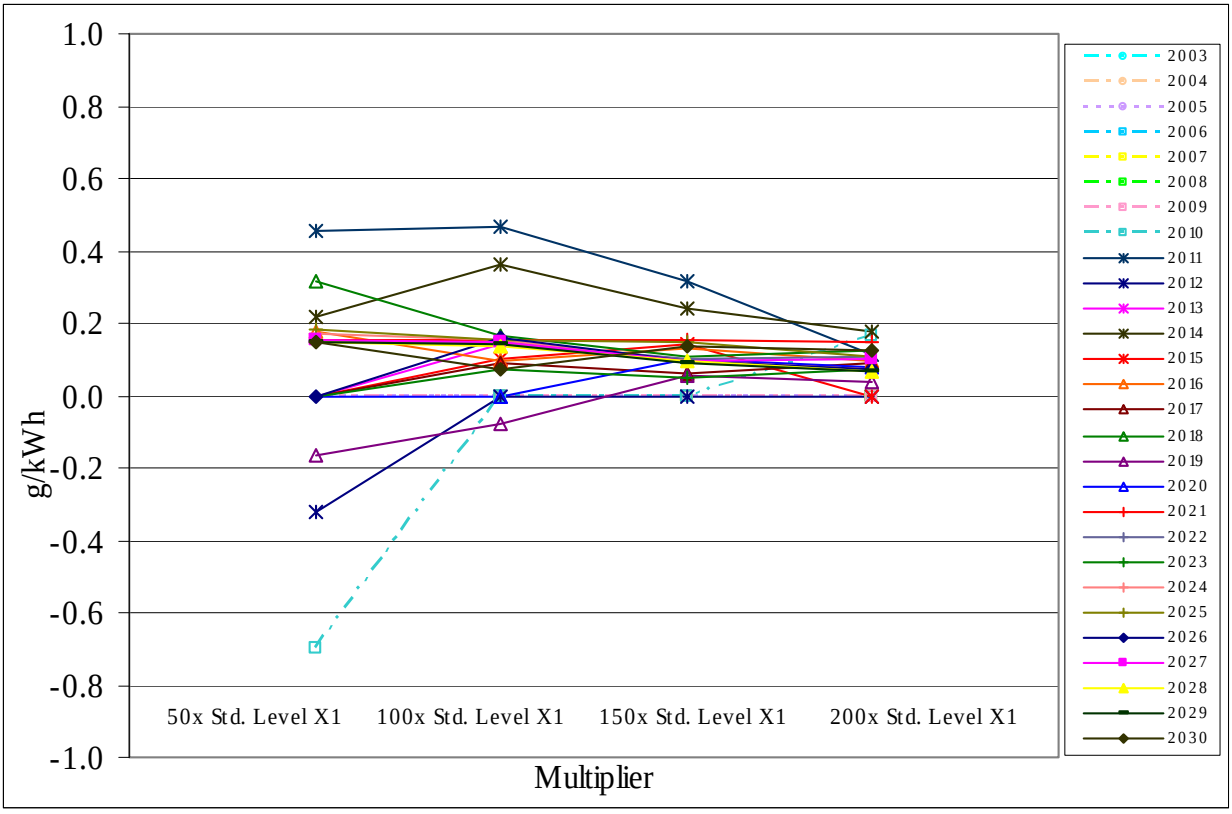

Figure 14A.2 An Example of Trial Standard Level: X1 Marginal NOx Emissions